Earth and Space Correlation Guide
2016 Science Indiana Academic Standards to 2022 Performance Expectations*

2016 Indiana Academic Standard	2022 Performance Expectation
ES.2.3 Develop a model illustrating the layers and life span of the sun. Explain how nuclear fusion in the core produces elements and energy, which are both retained through convection and released to space, including Earth, through radiation. Additionally, elements heavier than iron cannot form in stars, and form only as a result of supernova.	**HS-ESS1-1.** Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.
ES.1.2 Describe the expanding universe theory, also known as the "Big Bang Theory," based on observed astronomical evidence including: The Doppler Effect, red shift, Hubble's Law, and the cosmic microwave background.	**HS-ESS1-2.** Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.
ES.1.4 Differentiate between the life cycles of stars of different masses found on the Hertzsprung-Russell Diagram. Differentiate between low, medium (including our sun), and high mass stars by what elements can be produced, and therefore whether or not they can achieve red giant phase or go supernova.	**HS-ESS1-3.** Communicate scientific ideas about the way stars, over their life cycle, produce elements.
ES.2.4 Use mathematical and/or computational representations to demonstrate the motions of the various kinds of objects in our solar system including planets, satellites, comets, and asteroids. Explain that Kepler's Laws determine the orbits of those objects and know that Kepler's Laws are a direct consequence of Newton's Law of Universal Gravitation together with his laws of motion.	**HS-ESS1-4** Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
ES.6.3 Construct a diagram and explanation showing the convection of Earth's mantle and its impact on the movements of tectonic plates. Explain how the decay of radioactive isotopes and residual energy from Earth's original formation provide the heat to fuel this convective process, which, along with ridge	**HS-ESS1-5.** Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

2016 Indiana Academic Standard	2022 Performance Expectation
push and slab pull, drive the movements of tectonic plates. **ES.6.4** Create a timeline to show the development of modern tectonic plate theory. Identify and explain how the evidence from the theory of continental drift, seafloor spreading, and paleomagnetism built upon each other to support tectonic plate theory.	
	HS-ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.
ES.6.5 Create models that demonstrate different types of orogeny resulting from plate tectonics. Show how the interactions between oceanic and continental plates create different geological features (such as volcanic island arcs or high altitude plateaus) depending on what types of plates are involved in the motions along different plate boundaries. **ES.6.6** Create models and differentiate between shield, composite, and cinder cone volcanoes. Explain how volcanoes form, how the chemical composition of lava affects the type of volcanoes formed, and how the location (such as hot spots or along continental or oceanic margins) can affect the types of magma present. **ES.6.7** Use models, diagrams, and captions to explain how tectonic motion creates earthquakes and tsunamis. Using resources such as indianamap.org, analyze how close the school is to known faults and liquefaction potential. Differentiate between intraplate fault zones such as the Wabash Valley Fault System and the more commonly discussed faults along tectonic margins.	**HS-ESS2-1.** Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

2016 Indiana Academic Standard	2022 Performance Expectation
	HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
ES.6.3 Construct a diagram and explanation showing the convection of Earth's mantle and its impact on the movements of tectonic plates. Explain how the decay of radioactive isotopes and residual energy from Earth's original formation provide the heat to fuel this convective process, which, along with ridge push and slab pull, drive the movements of tectonic plates.	**HS-ESS2-3.** Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.
ES.3.3 Analyze and explain how events on one side of the world can alter temperature and precipitation around the globe. Analyze and explain the possible effects of natural and human-driven processes on our atmosphere and climate. **ES.4.2** Create models to demonstrate the circulation, retention, and reflection of heat in regards to the atmosphere, solid land, and bodies of water including lakes and oceans. Demonstrate the effects of cities, various terrain, cloud cover, sea ice, and open water on albedo. Examine local and global heat exchanges, including land & sea breezes, lake effects, urban heat islands, and thermohaline circulation. **ES.4.4** Create a model to demonstrate how the Coriolis effect influences the global circulation of the atmosphere. Explain how changes in the circulation of the atmosphere and oceans can create events such as El Niño and La Niña. **ES.4.6** Differentiate between weather and climate. Examine long term, natural climate change and periods of glaciation as influenced by Milankovitch Cycles due to the gravity of other solar system bodies (obliquity	**HS-ESS2-4.** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

2016 Indiana Academic Standard	2022 Performance Expectation
and precession of axis and eccentricity of orbit). Explain how these are different from any short term (less than thousands of years) changes to climate.	
ES.4.3 Create a presentation that demonstrates the process of the water cycle on both local and global scales. Illustrate the process of water cycling both from the solid earth to the atmosphere and around the solid earth. Examine the interaction of groundwater, surface water, and ocean circulation. Illustrate the effects of human activity on water systems. **ES.5.2** Create a rock cycle flowchart or diagram that demonstrates the processes involved in the formation, breakdown, and reformation of igneous, sedimentary, and metamorphic rock. Show how each type can melt and reform igneous rock, undergo the various metamorphic processes, and undergo physical and chemical weathering to form sedimentary rock. **ES.5.3** Construct a model that demonstrates the difference between weathering, erosion, transportation of material, deposition, and new soil and sedimentary rock formation. Differentiate between types of physical and chemical weathering.	**HS-ESS2-5.** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
ES.4.1 Create a model that shows the composition, distribution, and circulation of gasses in Earth's atmosphere. Show how carbon and oxygen cycles affect the composition through gas exchange with organisms, oceans, the solid earth, and industry.	**HS-ESS2-6.** Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
	HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
ES.4.2 Create models to demonstrate the	**HS-ESS2-8.** Construct an explanation of how

2016 Indiana Academic Standard	2022 Performance Expectation
circulation, retention, and reflection of heat in regards to the atmosphere, solid land, and bodies of water including lakes and oceans. Demonstrate the effects of cities, various terrain, cloud cover, sea ice, and open water on albedo. Examine local and global heat exchanges, including land & sea breezes, lake effects, urban heat islands, and thermohaline circulation.	heat (energy) and water (matter) move throughout the oceans causing patterns in weather and climate.
ES.4.4 Create a model to demonstrate how the Coriolis effect influences the global circulation of the atmosphere. Explain how changes in the circulation of the atmosphere and oceans can create events such as El Niño and La Niña.	**HS-ESS2-9.** Construct an explanation for how energy from the Sun drives atmospheric processes and how atmospheric currents transport matter and transfer energy.
ES.3.3 Analyze and explain how events on one side of the world can alter temperature and precipitation around the globe. Analyze and explain the possible effects of natural and human-driven processes on our atmosphere and climate.	**HS-ESS3-1.** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
ES.3.4 Evaluate the use of sustainable versus nonrenewable resources. Explain the consequences of overuse and continued increased consumption of limited resources. Analyze and evaluate the benefits of researching, designing, and developing sustainable resources for private use and industry.	**HS-ESS3-2.** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
	HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
	HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
	HS-ESS3-5. Analyze geoscience data and the results from global climate models to

2016 Indiana Academic Standard	2022 Performance Expectation
	make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
	HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

*Performance expectations are three dimensional. All three dimensions (Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts) must be included as part of effective instruction.

For more information, see the Indiana Department of Education's Indiana Academic Standards webpage or contact the Office of Teaching and Learning.